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ABSTRACT

Inadequacies in most life-span developmental studies are emphasized. A typical cross-sectional comparison of a sample of older adults' performances on a battery of measures revealed that non-surviving subjects and those who refused to be retested 5 and 10 years later scored consistently below retestees. These results point to a heterogeneity in the aging population and to biases in the sampling process, and suggest the need to define the population more specifically. Analysis of scores by going backwards in age starting with the time of death suggests the occurrence of lower limits in performance. Decline with age is attributed to a sudden drop in performance occurring within 5 years prior to subjects' deaths (terminal drop). Throughout adulthood, performances of long-term survivors are unchanged. The decline with age usually observed is attributed to the increasing number of subjects exhibiting terminal drops. The authors conclude that such psychological data, which indicate changing conditions of the biological organism, must be analyzed with regard to changing societal conditions. (TL)

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Development, Drop, and Death[1]

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In the past, most life-span developmental studies have focused upon changes of single variables and have reported a slow decline in functioning during the adult years (see, for instance, Birren, 1959, p. 24). Only a few researchers seem to have been aware of the dependency of these findings on the underlying model of development. Since the additivity of components, the uniformity of traits, and the continuity of development are basic features of this model, it is insensitive to multigenerational and multicultural differences. The aged and the child, the deprived and the delinquent are seen in negative terms, i.e., as deficient in comparison to the standard ideal of the young, competitive, white adult. Subsequently, this approach is unable to deal adequately with the unique functioning of such "deviant" groups, as, in our case, the aged. In the last section of our paper we will try to reevaluate the notion of single-standard, continuous growth processes, search for alternative conceptions of development, and emphasize the dependency of these interpretations upon scientific and social conditions.

By going beyond the traditional methods of cross-sectional and longitudinal comparisons, i.e., by applying complex developmental designs (Baltes, 1968; Schaie, 1965), it has become possible to disentangle the confounded factors of individual and social change. This has been successfully done in psychological gerontology (see for instance, Riegel, Riegel, & Meyer, 1967b; Schaie & Strother, 1968), but has not yet sufficiently penetrated other developmental areas (see however, Hilton & Patrick, 1969; Baltes, Baltes, & Reinert, 1970). Observations of

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selective survival and test participation have required further refinements in developmental designs. The first implies a lack of homogeneity of the adult population (Riegel, Riegel, & Meyer, 1967a), the latter a lack of uniformity in the sampling process across age levels (Riegel, Riegel, & Meyer, 1968). In order to derive unbiased estimates of population trends, Baltes, Schaie, and Nardi (1971) have suggested to define the population in more specific terms, for instance, in terms of the most important predictors of survival, longevity, or cooperation. Support for this suggestion will be provided.

Our analysis will describe a "terminal-drop" in performance occurring less than five years prior to the death of subjects. This observation, previously made by Kleemeier (1961, 1962), Jarvik and Falek (1963), and Lieberman (1965, 1966), has the potential implication that all observed changes might be attributed to the behavior of those persons who do not survive the next few years following the test administration. If we were to exclude these "high risk" subjects from the analysis little or no change might be observed. Stated differently, developmental trends may describe nothing but changes in mortality in the aging population; the observed decline may be due to the "terminal-drops" of non-surviving subjects whose number increases with age.

Methods and Procedures

Our report is based upon a cross-sectional study of the aged population in North Germany in 1956 (stage A), a retest-study after five years in 1961 (stage B), and two inquiries into the fate of the subjects from the original sample, the first in combination with the retest study in 1961 (stage B), the second ten years after the original testing in 1966 (stage C).

Subjects: The original sample at stage A consisted of 190 females and 190 males equally divided into five age levels ranging from 55 to over 75 years. Aside from controlling for age and sex, each age level was matched against census statistics on the following criteria: occupation or former occupation, source of income, marital status, refugee vs. non-refugee, and religious affiliation.

Insert Table 1 about here

Five years later, at the time of the second inquiry, all subjects had moved into the next higher age levels. As seen in Table 1, of the 380 persons originally tested, 202 participated in the second testing, 62 had died during the intervening years, and 116 resisted to be retested. Ten years later, at the time of the third inquiry, 162 subjects had died, 152 (or 75.3%) of the 202 retestees survived, but only 66 (or 56.9%) of the 116 retest-resisters. Thus, cooperation in retest-studies is a powerful predictor of survival.[2]

At the first investigation all 380 subjects were tested. From the information on the fate of subjects at stage B, average scores at the time of the first testing can be derived for three subgroups: retestees, non-survivors, and resisters. From the information on the fate of subjects at stage C, average scores at the time of both the first and the second testing can be derived for two further subgroups each;surviving retestees, non-surviving retestees, surviving resisters, non-surviving resisters.

Material: Both in the original and in the follow-up study the same battery of measures was applied, including the Hamburg Wechsler Intelligence Test for Adults, a 120-item free word association test, and a questionnaire on the social and living conditions of older persons. For the present interpretations we rely only on the following two additional sets of measures: Five multiple-choice verbal

achievement tests (Synonyms, Antonyms, Selections, Classification, and Analogies) which consist of 20 items each (Riegel, 1959, 1967), and four attitude and interest tests (rigidity, dogmatism, attitude toward life, adult interests) in which fourteen statements each had to be endorsed on five-point rating scales (Riegel & Riegel, 1960).

Results and Discussion

In the following analyses we rely on the summed scores of the five verbal tests and reduce the number of different age groups to two, i.e., we compare the performance of subjects below and above the retirement age of 65 years. Detailed comparisons between all five age groups including the results of variance analyses have been given elsewhere (Riegel, 1967, 1968; Riegel, Riegel, & Meyer, 1967b).

Homogeneity of the Population:: As shown in Figure 1a, the total means from the first cross-sectional study indicate a slight but not significant decline between the two age groups, $t(372) = .83$, $p > .05$. When the two samples are subdivided according to subjects' fate at the time of the second testing differential trends become apparent. Subjects retested at stage B have above average scores; in contrast to the decline in the total group, there is a slight increase in scores with age. Retest-resisters as well as non-survivors perform below average. The difference in scores between retest-resisters and retestees is larger for subjects above, $t(174) = 4.07$, $P < .01$, than below 65 years of age, $t(140) = 1.23$, $p > .05$. This and previous results (Riegel, Riegel, & Meyer, 1967a) suggest a more successful prediction of retest-resistance for the older than for the younger subjects. On the other hand, the difference in scores between non-survivors and retestees is about the same for subjects below, $t(107) = 2.25$, $p < .05$, than above 65 years of age, $t(153) = 2.20$, $p < .05$. This and previous results (Riegel, Riegel, & Meyer, 1968) suggest a more successful prediction of survivorship for the younger than for the older

subjects. The following conclusion can be drawn:

(1) Because of selective death of less able persons (especially at the younger age level) the population from which consecutive age samples are drawn is not homogeneous but, increasingly with age, becomes positively biased. Consequently, age trends reported in the literature underestimate the decline which would result if all subjects had the same chance of survival, i.e., if the population would remain homogeneous. Furthermore, age differences in the predictability of survival indicate that at the earlier ages death strikes subjects who are psychologically distinctly different from the survivors, i.e., less able. At the higher age levels death strikes more randomly and psychological differences between survivors and non-survivors are less marked.

Insert Figure 1 about here

Uniformity of the Sampling Process: Our results confirm for representative samples of subjects and - as shown elsewhere (Riegel, Riegel, & Meyer 1967b) - for a set of widely different psychological variables the findings on selective survival by Sanderson and Inglis (1961) and those reported on aging twins by Jarvik (1962), Jarvik and Falek (1963) and Jarvik, Kallmann and Falek (1962). Since the time of our first report (Riegel, Riegel, & Meyer, 1963), our results have been confirmed by studies in several countries (Baltes, Schaie, & Nardi, 1971; Berkowitz, 1965; Blum, Jarvik, & Clark, 1970; Britton & Britton, 1965; Clément, 1969, Eisdorfer, 1963; Granick & Birren, 1969; Palmore, 1969; Streib, 1966). Most of these studies are limited to measures of general intelligence or confound the differences between non-survival and retest-resistance. The separate analysis of our retest-resisters suggests a second conclusion.

(2) Because of selective retest-resistance (especially among the older subjects) the sampling process is not uniform across age levels. Over and above the effect of selective survival, and increasing with age, there is a tendency among less able persons to refuse to cooperate. Consequently, age trends reported in the literature underestimate the decline which would result if all subjects were to remain equally willing to participate in the testing.

The problem of selective test-participation, especially in longitudinal studies, has been recognized for a good many years (Ames & Walker, 1965; Kodlin & Thompson, 1958; Rosenthal & Rosnow, 1969; Sontag, Baker, & Nelson, 1958; Streib, 1966). Previously, attempts have been made to compare the performance of subjects recruited under increasing pressure to cooperate (Jones & Conrad, 1933), to describe groups of non-cooperative subjects in terms of their physique and physiology (Atchley, 1969; Damon, 1965), or in terms of overt social and economic variables (Britton & Britton, 1965; Rose, 1965; Sussman, 1964). Since we obtained the correlations between such overt variables and psychological measures, we have, previously, provided a more complete description of the non-cooperative retest-resisters (Riegel, Riegel, & Meyer, 1968). Of course, we do not have information on those persons who refused already to participate in the original testing.

Cross-Validation of the Results: Our inability to obtain psychological data from subjects who are never willing to cooperate can be compensated, to some degree, by comparisons of two of our subgroups delineated at stage C. Such comparisons, at the same time, extend our previous findings by covering a ten-year rather than five-year period. As shown in Figure 1b and Table 1, the group of retestees can be subdivided into those subjects who survived and those who did not survive the second five year period, i.e., until stage C. The same can be done for the retest-resisters. All of the following conclusions

are still being derived from the records obtained at the first time of testing.

The superiority of the surviving retestees in comparison to the surviving and deceased retest-resisters shown in Figure 1b is even more pronounced than the superiority of all retestees in comparison to resisters and non-survivors shown in Figure 1a. In particular, this is true for the older, $F(4,222) = 4.68$, $p < .01$, rather than the younger subjects, $F(4,147) = 2.17$, $p < .10$. The deceased retestees (see Figure 1b), on the other hand, are both below the scores of the surviving and the whole original group of retestees; they approximate, especially at the higher age level, the averages of the total original samples and those of subjects deceased prior to stage B (see Figure 1a).

More remarkable yet, the scores of the deceased retest-resisters are much lower than those of any other subgroup. For the older group, they are significantly lower than those of the non-surviving, $t(80) = 2.10$, $p < .05$, and surviving retestees, $t(109) = 4.22$, $p < .01$. For the younger group, the results point in the same direction although not as strongly, $t(16) = 1.60$, $p > .05$ and $t(89) = 1.96$, $p = .05$. The scores of the deceased retest-resisters parallel those of subjects dying prior to stage B (see Figure 1a), they are lower, though not significantly lower, than the scores of the surviving retest-resisters, $t(41) = -1.48$, $p > .05$ for the younger group, $t(71) = -.81$, $p > .05$ for the older group. Again, the distance in scores between the surviving retest-resisters and the total group (see Figure 1a) is larger for the older than for the younger subjects, allowing for more successful prediction of retest-resistance at the higher age level. Survival, on the other hand, can be more successfully predicted for the younger group. Here the distance between the deceased retest-resisters and the total group (see Figure 1a) is larger for the younger than for the older subjects. Our results suggest the following conclusion:

(3) When information on subjects' fate ten years after the original testing is used, the results obtained from information on subjects' fate five years after

the original testing are confirmed and accentuated. The overall age difference in performance or behavior is an artifact caused by the continued participation at the higher age levels of the surviving and cooperative subjects to the exclusion of non-surviving and non-cooperative subjects. The former are found to be above average in performance or behavior, the latter below.

Negative Age and Lethal Limits: The lack of homogeneity in the aging population and the lack of uniformity in the sampling of aged persons can be documented in an alternative manner by using the last time of observation, i.e., 1966, as the zero-point of a time scale and by analyzing the data in terms of negative age. For such an analysis we compare the average scores of all subjects who were alive at stage C in 1966 (surviving retestees and retest-resisters) with those who had died during the preceding five years (deceased retestees and retest-resisters), and with those who had died between five and ten years prior to stage C (non-survivors).

Insert Figure 2 about here

As shown in Figure 2, subjects who died prior to 1966 have markedly lower test scores than those still alive. This trend is especially consistent for subjects below 65 years of age, while the older subjects, being closer to the "natural limit" of their lives, show this trend less clearly. When going from left to right along the age scale, the surviving subjects attain higher and higher averages and, as indicated before, represent increasingly positively biased groups. Most remarkable, subjects still alive in 1966 attain an average score of 10 which is identical with that attained at the age of peak performance, i.e., at 30-34 years. Thus, surviving subjects do not seem to have changed in performance during the major portion of their adult life.

The results of Figure 2 also suggest that the performance of non-survivors has dropped before their death toward a lower, lethal limit. This proposition can be summarized in the following form:

(4) There exist lower limits in performance or behavior attained by subjects shortly before their death. If subjects fall below such lethal limits (or raise above, depending upon the type of measurement taken) their chances for survival are slim. For superior subjects, being remote from these limits, it may take a longer time of approach than for inferior subjects, i.e., superior subjects live longer.

Insert Figure 3 about here

The occurrence of lethal limits in performance or behavior can be well documented for the attitude scales. As shown in Figure 3, non-survivors at all five age levels attain "General Rigidity" scores of about 20 points. The rigidity of the retest-resisters but especially of the retestees and of the total group is far below this value. Rigidity increases steadily with age, however, until it reaches the upper limit of 20 points during the highest age level investigated, i.e., above 75 years. At this level, the differences between non-survivors, resisters, and retestees have vanished; the chances for survival are about equally low in all these groups; the selection of the survivors seems to be randomly determined (see conclusion 1).

These interpretations are substantiated by our statistical analyses. Only the variance analyses for subjects below, $F(2,149) = 3.86$, $p < .05$, but not above 65 years, $F(2,225) = 2.82$, $p < .10$, yield significant differences. For the younger subjects, t-test comparisons between non-survivors and retestees, $t(107) = 2.05$, $p < .05$, and resisters and retestees, $t(140) = 2.13$, $p < .05$, are significant, for

the older subjects, only the comparison between non-survivors and retestees, $t(153) = 2.03$, $p < .05$.

Terminal Drop in Performance or Behavior: All our preceding interpretations have been derived from the data of our first testing at stage A. From the data obtained at stages B and C we have used only the information on the fate of our subjects in order to subdivide our original samples into the various subgroups shown in Figures 1a and 1b. At stage B, a large portion of subjects was retested and, thus, our previous analyses can be supplemented by longitudinal comparisons. As shown in Figure 1c, our longitudinal records can be subdivided into those of retestees who survived and those who did not survive the five years following the retesting at stage B.

The retest scores of the younger, surviving retestees (dotted line) fall closely upon the line derived from the original, cross-sectional records (solid line) and thus confirm the earlier results. The longitudinal data for the older surviving retestees, extending five years beyond the cross-sectional comparison, drop off rather sharply, however. The same result has been obtained for those retestees who did not survive the five years following the second testing. Here, the longitudinal means for both the younger and the older group drop-off rather sharply and, therefore, deviate from the original, cross-sectional trend. Since, in general, renewed exposure to the procedures in a retest study should have improved subjects' performance rather than produced a decline in three out of four cases, we are confident in drawing the following conclusion:

(5) Changes with age in performance or behavior, hidden by better selective survival and greater cooperation of persons above average, are caused by sudden deteriorations occurring during periods extending over less than five years prior to subjects' death. Little or no decline seems to occur during earlier periods of adulthood and aging.

Our longitudinal data of surviving and deceased retestees confirm some previous research by Kleemeier (1961, 1962), Jarvik and Falek (1963) and Lieberman (1965, 1966) in which, through repeated testing, a sudden terminal drop in performance or behavior was observed. We still need an explanation, however, for the drop in scores of the older surviving retestees (see upper right section of Figure 1c) which is inconsistent with our interpretation. Perhaps, these subjects, having by the time of the retest attained an age of at least 70 years but at most of 93 years, are so close to the "natural limit" of their life that the terminal drop is already occurring even though they are still cooperating in the testing. In support of this interpretation it is noteworthy that their drop in scores is less marked than that of the deceased older retestees (see lower right section of Figure 1c). This explanation requires, of course, an extension to over five years of the period during which such a terminal drop might occur. It is congruent with our previous suggestion that the length of this period is a function of subjects' overall performance level, i.e., that superior persons have longer drop-periods than inferior ones (see conclusion 4). By combining these interpretations we arrive at a more staggering formulation.

At any time during adult life, subjects who perform below average are closer to death than their more able age mates. Differences in scores within adult age groups might, thus, be a function of survival probability; subjects scoring low are closer to death and/or have already experienced their terminal drop; subjects scoring high retain their abilities and have a good chance for survival. Differences in scores between adult age groups (hidden by selective survival and retest-resistance) reflect the increasing number of persons with terminal drops. Any observed decline in average scores might be attributed to those subjects likely to die. The performance of the long-term survivors remains stable.

Differential Changes as a Function of Tasks and Performance Levels: Considerable evidence has been accumulated on the dependency of developmental changes on the original level of functioning (Berkowitz & Green, 1965; Birren & Morrison, 1961; Granick & Friedman, 1967; Miles & Miles, 1932; Riegel, 1968, Schaie & Strother, 1968; Vernon, 1947), indicating a better maintainance of performance for subjects with superior abilities. Below average or inferior subjects, on the other hand, have often been found to show slower growth, lower peak performances, and more rapid deterioration during later years of life (Baller, Charles, & Miller, 1967; Kaplan, 1943, 1956; Kaplan, Rambaugh, Mitchell, & Thomas, 1963; Muench, 1944; counterevidence by Bell & Zubeck, 1960).

Despite these findings, the results from the early longitudinal studies by Terman (Bayley, 1970; Bayley & Oden, 1955; Terman & Oden, 1947) as well as from the follow-up studies by Owens (Owens, 1953, 1959; 1966; McHugh & Owens, 1954; Thompson, 1954), showing a stability or even increases in performance during the adult years, have been interpreted as providing counterevidence to the decline in functioning reported in the well known cross-sectional studies by Jones and Conrad (1933), Miles and Miles (1932), Wechsler (1944) and others. Little was it realized that these investigations of superior persons confirm the dependency of the decline on the level of functioning but do not provide direct evidence in support of age changes in performance for the average or below average population. In extending this analysis, we will show that differences in the rates of decline also interact with the type of functions measured.

Including 120 young subjects in our analysis (for a description of this group see Riegel, 1967; Riegel, Riegel, & Meyer, 1968), we increased the total sample to 500 persons. Out of this group we selected separately for each of four verbal tests those 15% of the subjects who scored highest and those 15% who scored lowest. Relying on the individuals' scores rather than on means for age groups, we computed

the average trends for these two extreme groups on each of the four tests. In order to compare the relative gains across age groups and across tests, we converted the scores by linear transformations in such a manner that at the age of peak performance, i.e., at 30 to 34 years, the average scores on all four tests and for both groups were equal to zero.

Insert Figure 4 about here

As shown in Figure 4, the differences between the upper and the lower group are largest and increase with age (at least up to 74 years) on the classification test. They are smaller but increase more consistently on the selection test. For the antonym test the differences remain zero. For the synonym test, however, the differences are at first relatively large but decrease with age. After the age of 55 years, the rate of gain is consistently larger for the lower than for the upper group. These results suggests the following conclusion:

(6) Developmental differences in performance are both dependent upon the level attained by subjects and the type of variable measured. Superior subjects, generally, show a faster rate of growth and a slower rate of decline; inferior subjects, generally, show a slower rate of growth and a faster rate of decline. This holds consistently for tasks relying on unfamiliar material and new choices (classification and selection tests). Thus, the distance between the two groups (or the variability of the whole group) increases with age. On tasks relying on familiar material and redundant choices (synonym test), however, inferior subjects show a slower rate of growth than superior subjects but, by maintaining this rate during the whole life span, the distance between the two groups (or the variability of the whole group) decreases during the later years of life.

Results as obtained on our classification and selection tests have been interpreted by Thompson (1954) and Owens (1959) as indicating that "age is kinder to the initially more able". For the synonym test, however, our results suggest that "the last shall be the first". Superior persons retain their high performance level but less able persons steadily catch up.[3]

Because of these task differences, the results cannot simply be dismissed as a regression phenomena. Only the trends of the synonym test could lend themselves to such an interpretation. These results rather indicate that the psychological fate of subjects is not as rigidly fixed as earlier research, e.g., on the constancy of the IQ, has made us believe. The naivete of the traditional approach is, indeed, perplexing and led the present authors to perform a test analysis across age levels, searching systematically for items on which older subjects would do better than the young (Riegel & Riegel, 1962). By adding new items to the test favoring the old and by eliminating those in which their performance was inferior, an intelligence test, quite reasonable in appearance, was constructed that showed continued improvement in scores with age.[4]

Although these issues were expressed early in the history of psychological gerontology (Thorndike, Bergman, Tilton, & Woodyard, 1928; Lorge, 1936), the prevailing attitude remains one in which the investigator arbitrarily selects a measuring device, such as an intelligence test, and applies it with little psychological sensitivity to groups of older persons. The outcome of such an approach necessarily results in the conclusion that the young and the old, the deprived and the delinquent are inferior in comparison to the standard ideal which often enough represents the young competitive, white adult. Thus, our evaluations remain culturally biased and fail to do justice to the deviant group of concern to us, i.e., to the aged individuals.

Conclusions and Implications

Theoretical Models: The evidence of a terminal drop suggests that in a homogeneous adult population there may be no or only small gradual changes in performance and behavior. Since mortality increases with age, however, we observe an apparent decrement produced by the increasing number of persons exhibiting such a drop prior to their death.

This interpretation might consolidate several findings and theoretical issues. Thus, it integrates the argument that intellectual operations once apprehended (e.g., the conservation of matter, weight or volume) can not be lost unless physiological deterioration or damage occurs (Flavell, 1970; Flavell & Wohlwill, 1969) with the well documented observation that performance (e.g., as measured by an intelligence test) declines indeed during the later years of life. According to our findings, such intellectual competence does not seem to be lost. The observed decline in performance is an artifact produced by the increasing occurrence of terminal drops during the later years which, in turn, might be caused by physiological deterioration or damage.

Our interpretation also eliminates the discrepancies between cross-sectional and longitudinal findings. The latter, being obtained from surviving and cooperative retestees, have consistently shown a high stability in performance at least for middle aged adults. Cross-sectional studies, however, include at various age levels subjects who are likely to die within a few years and who are already exhibiting terminal drops. Thus performance or behavior shows a decline in all but a few of these studies.

Our interpretation, to be called the "terminal drop - mortality model", does not yet consider individual differences in selective survival, i.e., the evidence that the more able person lives longer. It assumes that death strikes all persons in a random manner, although the chances for survival decrease systematically with

age. The observation of individual differences in survival ability calls attention to the influence of systematic selection factors. For a first extension of our modal we assume a connection between biological factors of longevity and those performances and behaviors that are predictive of survival (see Riegel, Riegel, & Meyer, 1967a). In other words, we propose that there exist strains of individuals who perform at different levels and differ in longevity. Both these factors covary and are biologically determined.

Our modified interpretation might be called the "biological, terminal drop - mortality model". Within the present context, we leave unexplored any details of the biological determinants and connections (see, however, Strehler, 1962). It seems of greater interest to consider another modification of our original interpretation which might be called the "sociological, terminal drop - mortality model."

Such a model assumes individual differences in performance and longevity without specifying whether these are primarily determined by intrinsic or extrinsic factors. Certain persons cope less well with their environment, for instance, they receive less education, lower income, worse nutrition and fewer medical assistance. Subsequently, their chances for survival are lowered and their performance drops earlier in life than that of their more favored age mates. In comparison to the biological model, such an interpretation involves an explication of the ecological determinants of survival and, thus, points to propaedeutic possibilities for changing the course of development through social actions (Riegel, 1971c, 1972). It is for these reasons that we ought to pay special attention to such an interpretation.

Ecology of Changes: If selective survival is influenced by social conditions, then the rapid historical changes, especially in the industrialized countries, must have a powerful effect upon the changes in the individuals observed in psychological investigations. As maintained by Ryder (1965), individual changes

might be negligible compared to the modifications in the society. Similar arguments have been made in regard to the more specific roles of the individual in scientific and artistic developments.

As shown by Burton and Kebber (1960), Price and Beaver (1966), Riegel (1969, 1971a,d)and others,an increasingly faster substitution of one cohort of scientists by the next seems to have occurred during recent historical periods. Each cohort makes its contribution during short periods of time only and thereafter steps down or is pushed into the background by a new scientific generation without much consideration for the capacities of the participating individuals. This turnover in intellectual positions produces serious problems for the individuals as well as for the social group. If, as it happens, earlier cohorts are not sensitive enough to yield to later ones, a "generation gap" develops and induces the younger group to call for necessary changes by force. Such conditions will be aggravated if the speed of cohort substitution does not keep pace with changes in a wider historical-cultural context, for instance in national or international relations. In such instances a third cohort, e.g., the present day student generation, may already claim leadership at a time when the first is still in power and the second has not yet attained it.

Even changes within relatively well defined groups, e.g., the Department of Psychology at The University of Michigan, have to be analyzed in this manner (Riegel, 1970). Originally, when the department was small, changes were brought about by the changing orientations, i.e., by the "aging", of the constituting staff members. With the large increase in size after the end of the second world war, however, changes were produced by selective hiring through which, in turn, early cohorts were substituted for by new subgroups at an increasingly faster pace.

Without doubt, developmental psychologists have paid insufficient attention to changes in the social environment which, necessarily, confound all psychological observations. Recently, however, the study of developmental changes has received

much conceptual clarification. The developmental research designs proposed by Schaie (1965) and Baltes (1968) enable us to disentangle historical-cultural changes from those in the individual. These reevaluations have also dismissed the naive and mechanistic notion of child psychologists, that there exist "true developmental trends" and that the major goal of developmental studies should consist in "detecting" these trends. Changes in the individual always reflect changes of the society; changes of the society reflect changes of the individual (see Baltes & Labouvie, 1971; Riegel, 1971b; Schaie, 1972). Schaie has also claimed that these developmental designs permit inferences about the relative impact of biological vs. sociological determinants upon development. With his claim, this interpretation becomes very similar to the philosophical arguments by Rubinsteijn to whom, therefore, we will address our attention in the final section.

Dialectic Theory of Development: Rubinsteijn (see Payne, 1968) attributes psychic events and their development to two interaction processes. The first explains these events in relation to their material, biological basis. This type of exploration, representing the influence of Pavlov, would constitute an insufficient basis, however, for explicating behavior. Rather, psychic events are co-determined by the material, historical-cultural contingencies within which they are taking place. This type of exploration represents the influence of the dialectic materialism introduced into developmental studies by Vigotskij, Luria, and Leontiev. Neither of the two interaction processes provides for a reduction of psychic events to material-biological or material-historical-cultural bases. Psychic events are rather regarded as constructs at the intersect of these two relational systems, an idea most clearly expressed by Rubinsteijn's notion of "constitutive relationism", i.e., of the subordination of elements to relations and structure.

In order to explicate the first modification of our model, the "biological, terminal drop – mortality model", we would have to explore the conditioning history

of an individual which, ultimately, is anchored to the biochemical bases of the organism. Such an exploration, taken alone, would not provide a sufficient interpretation, however, because, at the same time, psychological changes are determined by the historical-cultural conditions under which they occur. These aspects are expressed in the second modification of our model, the "sociological, terminal drop - mortality model," and concretely by the income, nutrition, education and medical circumstances under which conditioning processes are taking place.

As much as the later version of Pavlov's theory implies the notion of an active organism (i.e., an organism who searches instrumentally for stimulation as much as stimulation is imposed upon him), so does the second interaction process imply the notion of activity. The organism responds to and shapes the environment as much as the environment responds to and shapes the organism. In its strongest version, the social philosophy implied here requires that the environment actively imposes upon the individual its educational, medical, and nutritional facilities. It is not sufficient merely to make these opportunities available, but also necessary to induce them upon the individual through social actions.

Undoubtedly, the interaction theory of Rubinsteijn delegates psychological research and theory to a secondary position. The material-biological and material-historical-cultural conditions of the two interaction processes represent more fundamental bases. However, psychology is neither reduced to other disciplines nor is it eliminated from consideration. The psychic activity of the organism influences in a dialectic manner both the biological and the historical-cultural conditions as much as it is influenced by them. As stated most pointedly by Payne, man "creates himself by his own labor — by transforming nature he transforms himself (1968, p. 90)". The mere recording of psychological events, for instance, of developmental trends, is considered, however, as producing superficial

results or illusions.

This conclusion describes our state of affairs precisely and well. As we have demonstrated through the analysis of our verbal tests and through a brief review of the literature, data obtained in cross-sectional comparisons indicate significant losses with age in performance. Longitudinal comparisons have produced different results. The full implications of both these findings can be understood only if the observed psychological differences and changes are analyzed with regard to the changing conditions of the society as well as in view of the changing conditions of the biological organism. Psychological data in separation, as commonly obtained in developmental studies, are misleading and useless.

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Footnotes

[1]The editorial comments by John A. Meacham are gratefully acknowledged.

[2]Since we did not keep record of the 10 or 15% of subjects who refused to cooperate at the very first testing, it is not possible to generalize this conclusion from the retest-resisters to the original test-resisters. Nevertheless, such a generalization is most reasonable. Future investigators should be advised to record the names of all subjects approached in order to check on the survivorship of non-cooperative subjects.

[3]By extrapolating the unadjusted trends for the upper and lower groups it is possible to predict that the latter shall surpass the former at an expected age of 163 years. It will be left to the imagination of the reader to find an interpretation of this second zero point in the measurement of performance, a point at which, as for Thurstone's zero point in intelligence, 1928, the variability of the whole group is reduced to zero and which, appropriately, might be called the "eternity point".

[4]The arguments implied are the same as those discussed in the recent controversy on the application of tests to minority groups. Here the goal is to develop instruments that "maximize" the performance of minority groups (Williams, 1970).

Table 1

Fate of Subjects at Stages B (1961) and C (1966)

Stage B	Stage C	55-59	60-64	65-69	70-74	75+	All Ages
Retestees		51	48	44	34	25	202
	Surviving	(47)	(39)	(33)	(19)	(14)	(152)
	Deceased	(4)	(9)	(11)	(15)	(11)	(50)
Non-Survivors		2	8	12	17	23	62
Resisters		23	20	20	25	28	116
	Surviving	(22)	(16)	(13)	(15)	(23)	(66)
	Deceased	(1)	(4)	(7)	(10)	(5)	(50)

Note: N = 76 in each age range. Total N = 380. All ages are those attained at the time of the first testing. As for the population, mortality in our sample increases more rapidly with age for men than for women. The number of non-surviving males (fourth line) increases as follows across the five age groups: 1, 6, 9, 9 and 16. Since sex differences did not systematically influence the psychological prediction of longevity, they have been disregarded in the present report. Sex of subjects is by itself, of course, a powerful predictor of longevity. (See Riegel, K.F. The prediction of death and longevity in longitudinal research in F.C. Jeffers & E. Palmore (Eds.) Prediction of life-span. Springfield, Ill.: Charles C. Thomas, 1972 - in press).

Figures

Figure 1. Average scores on five verbal tests for two age levels, various subgroups, and two times of testing. a) Cross-sectional analysis at stage B; b) Cross-sectional analysis at stage C; c) Longitudinal analysis at stage C. (Note: solid lines = cross-sectional comparisons; dotted lines = longitudinal comparisons).

Figure 2. Average scores on five verbal tests for two age levels as a function of negative age.

Figure 3. Average scores in general rigidity at the time of the first testing for five age levels and three subgroups.

Figure 4. Differential trends for the highest (H) and lowest (L) 15% of subjects on four verbal tests (Sy = synonyms; At = antonyms; Se = selections; Cl = classifications).

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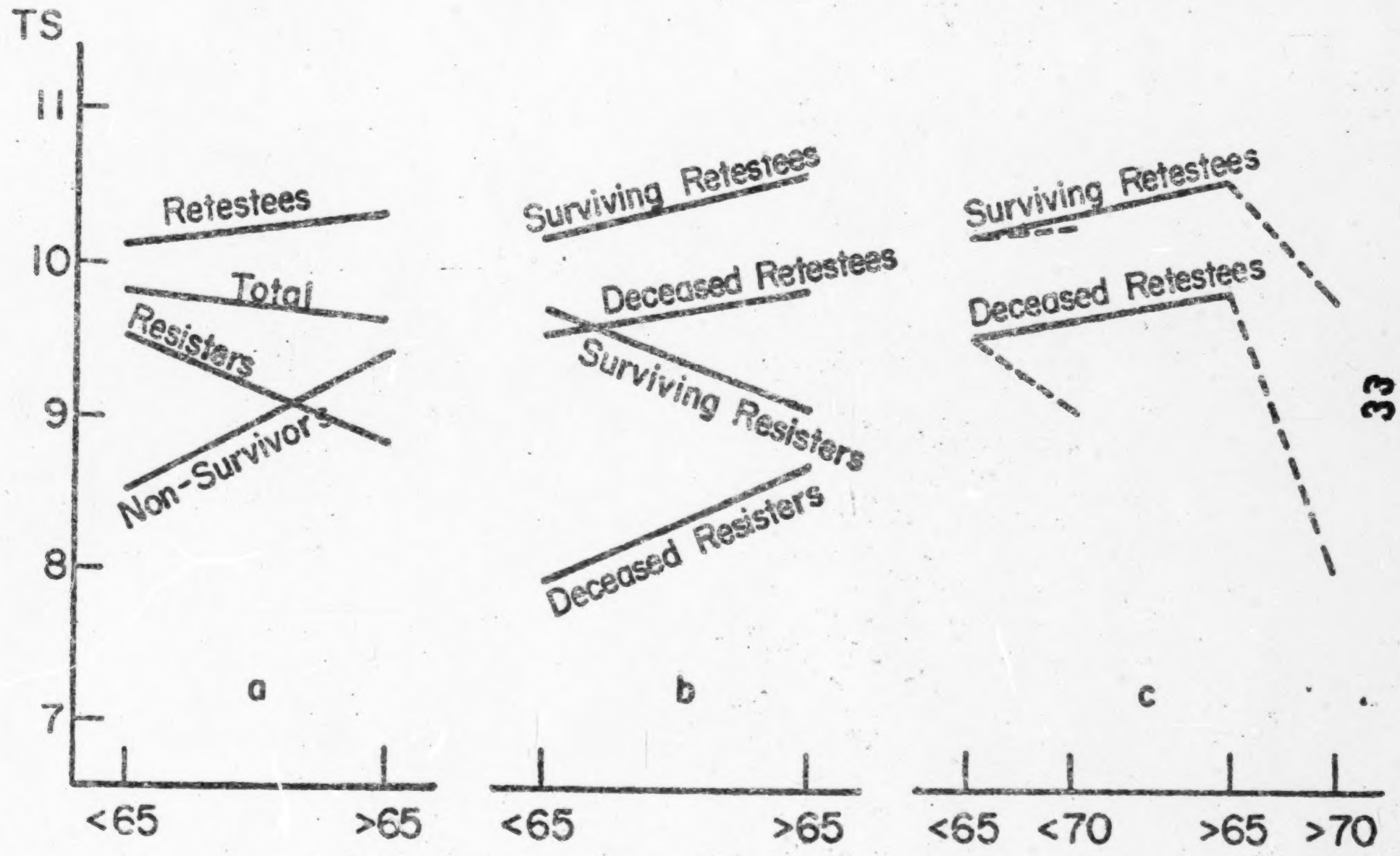
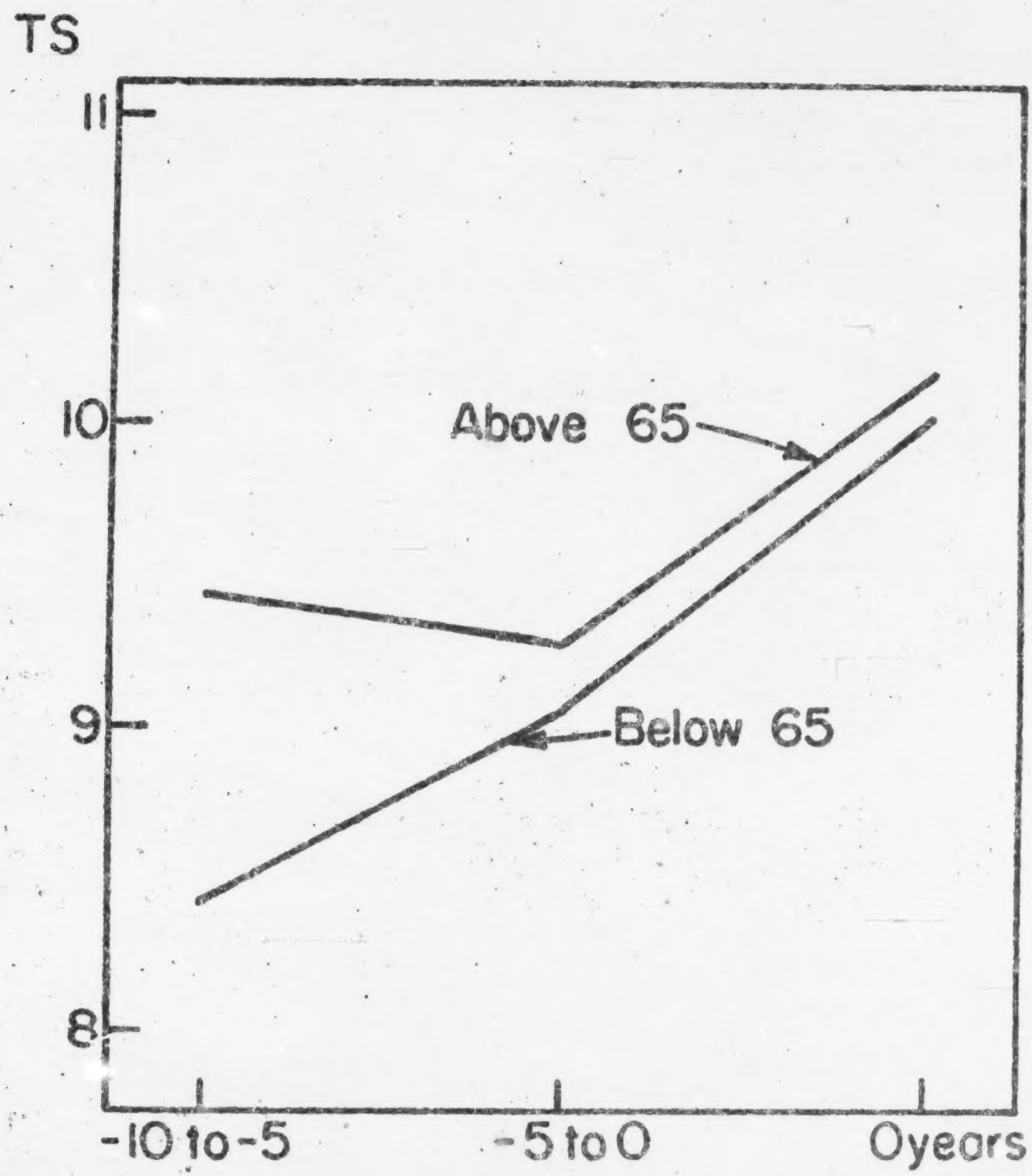


Fig. 2. Average scores on five verbal tests for two age levels as a function of negative age.



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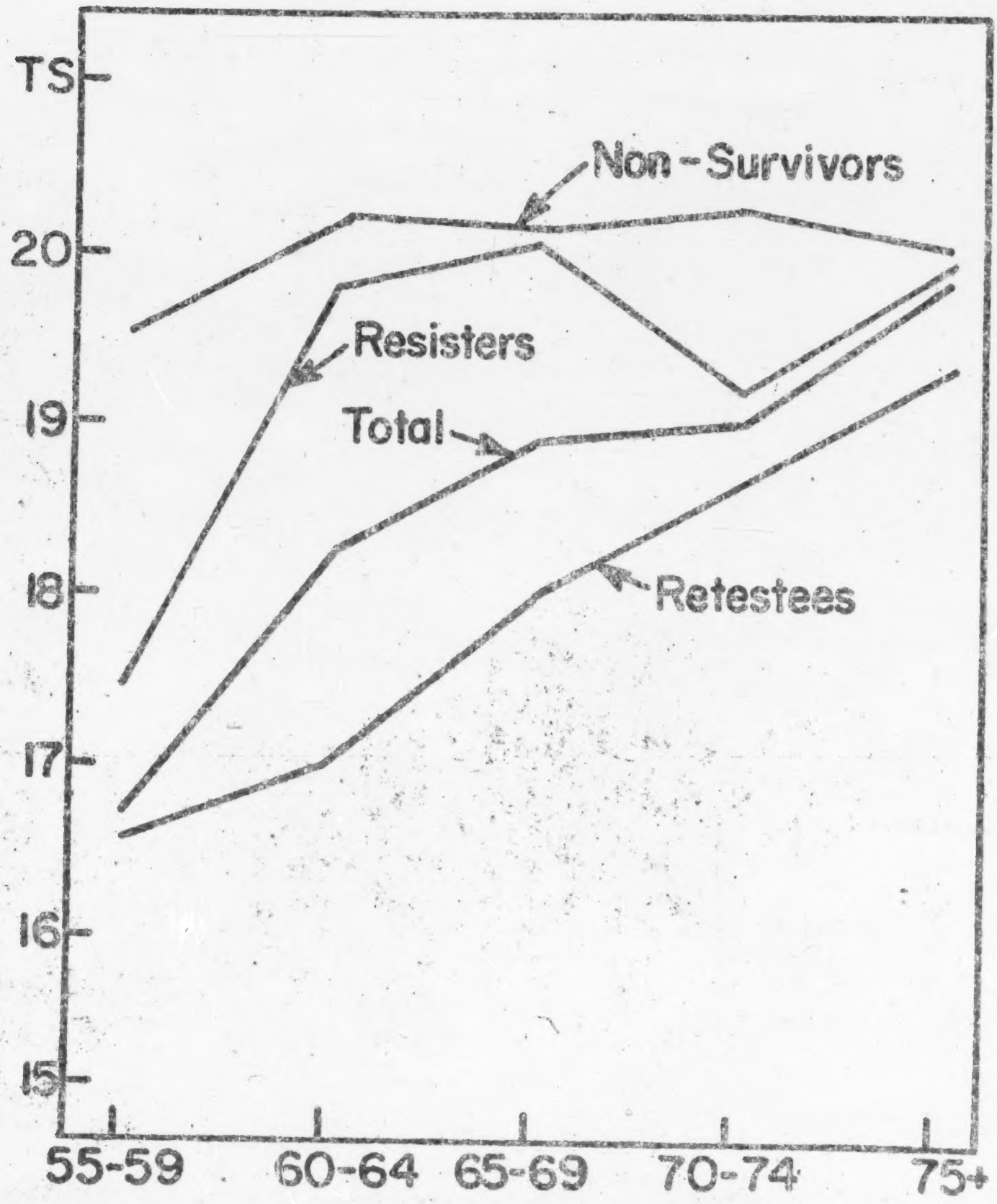

Figure 4: Differential trends for the Highest (H) and Lowest (L) 15% of Subjects on Four Verbal Tests. (Sy = Synonyms; At = Antonyms; Se = Selections; Cl = Classifications).